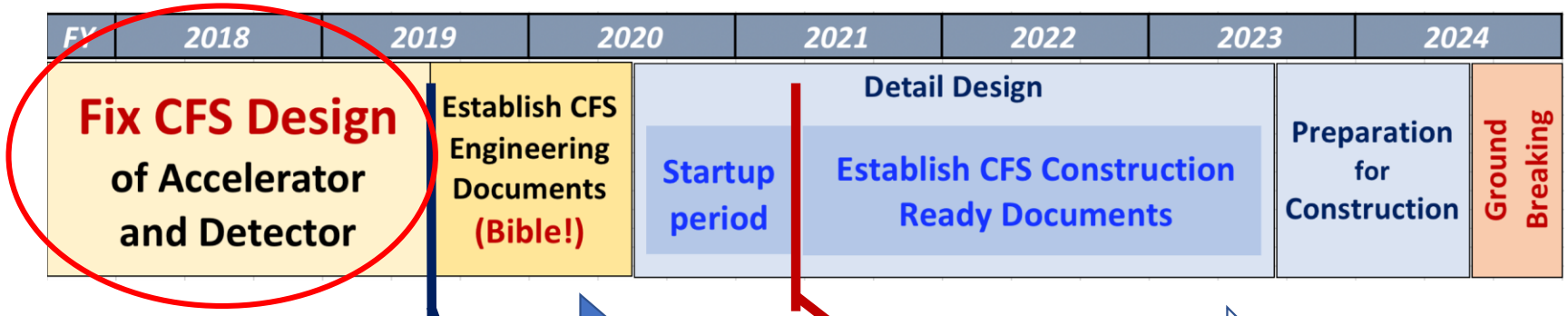
ILC 250GeV overall tunnel design

Summary and review

H. Hayano KEK

Slide from N. Terunuma

CFS timeline on "Pre- and Preparation Phase"



Our possible contribution → minor correction only

(A) Basic Design linked to CFS should be fixed.

- **Accelerator layout**
  - beamline
  - power supplies
- **Requirement of Utilities**
  - specification and route

(B) Selection of Positron Source Scheme

Note:
This timeline has been discussed and reached a consensus by the KEK LC-CFS members.

- M. Miyahara,
- H. Hayano,
- N. Terunuma,
- S. Michizono,
- K. Yokoya

Exception: Positron Source

- **Prepare designs for <u>all possible schemes</u> by (A)**
- **Scheme choice should be done by (B)?**

CFS Timeline, Nobuhiro Terunuma (KEK), 29 May 2018, ALCW2018, Fukuoka.

What is required for CFS in coming 1 year? -> Fix CFS design to be the reference of CFS engineering Document

Roadmap to fix CFS design

***Utility design shoud be done in parallel**

(1) Reconfigure the lattice of ILC250 (BD, Source, DR, BDS)

Create ILC250 lattices from TDR lattice, or by revision

Build several option of positron lattices

(2) Reconfigure the tunnel & cavern design of ILC250 (CFS)

Create ILC250 tunnels and caverns from TDR design and from revised design

Build shield room design of beam dump and target in the tunnel design

Build access tunnels in there

(3) Create 3D CAD design (the reference design) of ILC250 (CFS)

What was done for ILC250 CFS design

1. ILC250 configuration review/update

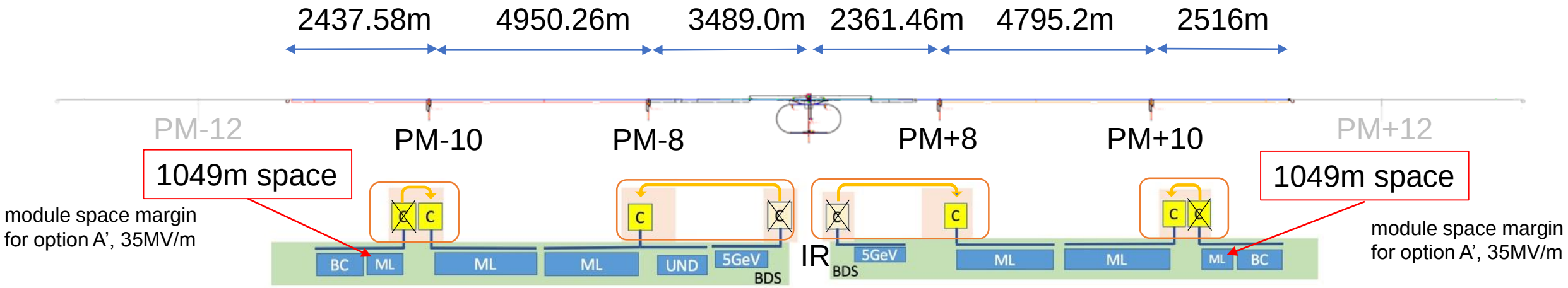
2. TDR/ILC250 beam dump review/update

3. TDR/ILC250 positron-side BDS review/update

4. TDR/ILC250 positron generation and electron BDS review/update

ILC250 configuration review/update

Option A' **ECM=250GeV** **SRF 35MV/m**



Ecm=250GeV

	BC				e+inj		e-inj				BC
	51	90	189	189	24	module space	24	180	189	90	51
	51	4.5	189	189	24	cryomodules	24	180	189	4.5	51
	17	1	42	42	8	RF unit	8	40	42	1	17
e^- 135.6GeV =	10.0	1.4	59.6	59.6	5.0	E gain (GeV)	5.0	56.7	59.6	1.4	10.0 = e^+ 132.7GeV

+6.2%margin

Total tunnel length = 20549.5m (20.5km)

The International Linear Collider Machine Staging Report 2017

Addendum to the International Linear Collider Technical Design Report published in 2013

Linear Collider Collaboration / October, 2017

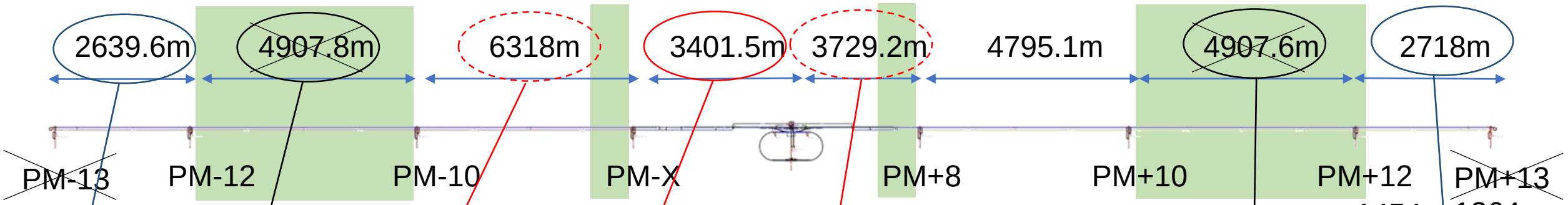
Editors:Lyn Evans and Shinichiro Michizono

Acc. length manipulation from TDR Recent Optics Deck

Ecm = 500GeV

timing path length is matched with n=10

Total length of TDR accelerator = 17266.9m+16149.9m=33417m



remove this length
for option-A
delta-L = -4907.6m

3401.5m + 87.5m = 3489m
Vertical bend

Option A' with n=6

2718m – 404.04m/2
=2516m
Timing adjust

2639.6m
– 404.04m/2
=2437.48m
Timing adjust

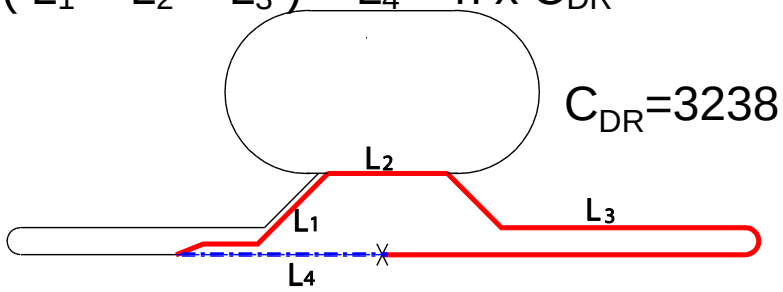
remove TDR timing adjust
6318m – 1367.74m = 4950.26m

(2015 Okugi BDS) + 87.5m = 2361.46m
Vertical bend
delta-L = -1367.74m
remove TDR timing adjust

remove this length for option-A
delta-L = -4907.6m

collision condition

$(L_1 + L_2 + L_3) - L_4 = n \times C_{DR}$



C_{DR}=3238.68m

$(L_1 + L_2 + L_3) - L_4 = (L_1'+87.5)+L_2+(L_3'-1367.74x2-4907.6x2 -X) - (L_4'+87.5)$

$=(L_1'+L_2+L_3')-L_4' -(12550.68m +X)$

$=10 \times C_{DR} - 4 \times C_{DR}$

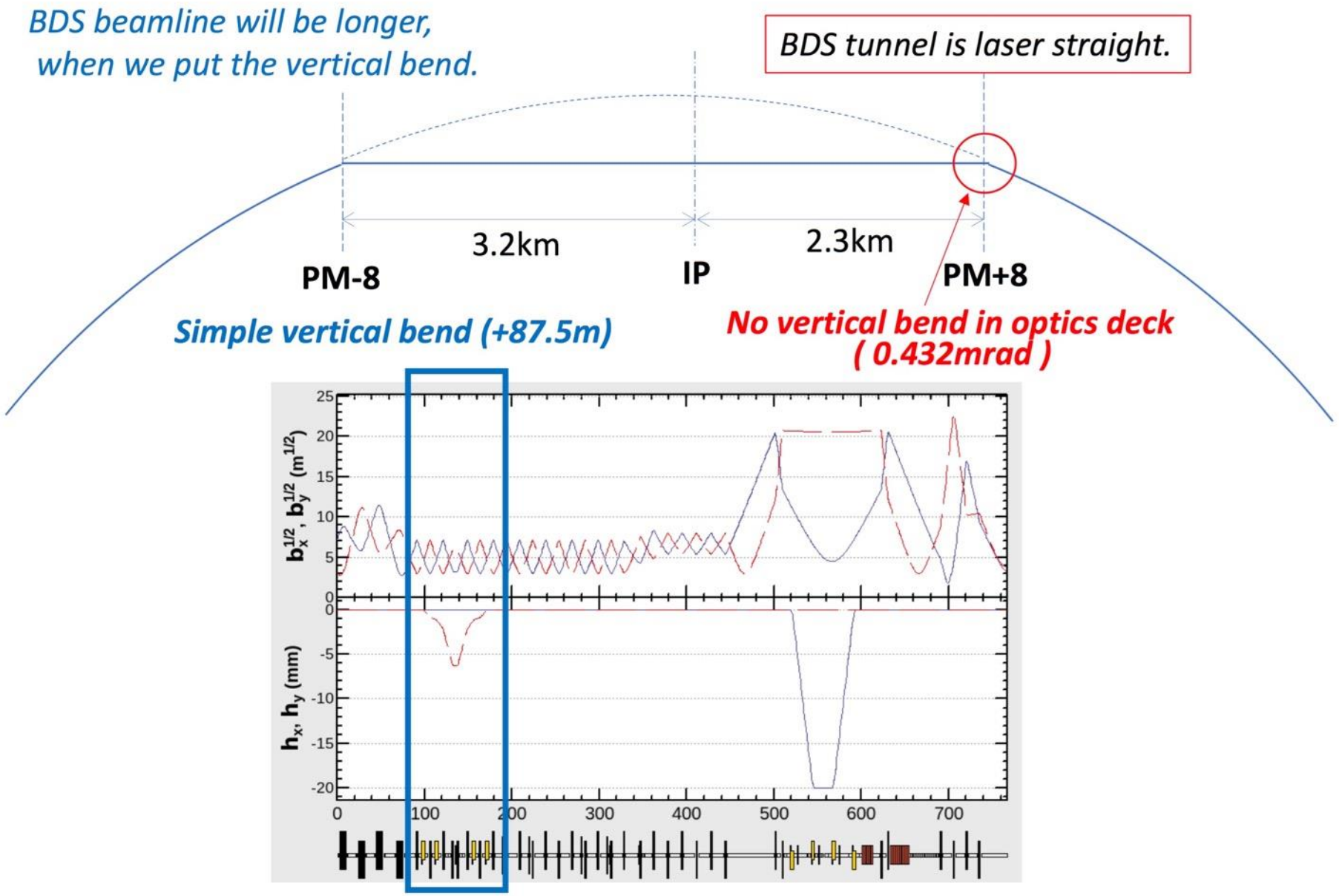
$= 6 \times C_{DR}$

$4 \times C_{DR}$=4 x 3238.68m = 12550.68m + X

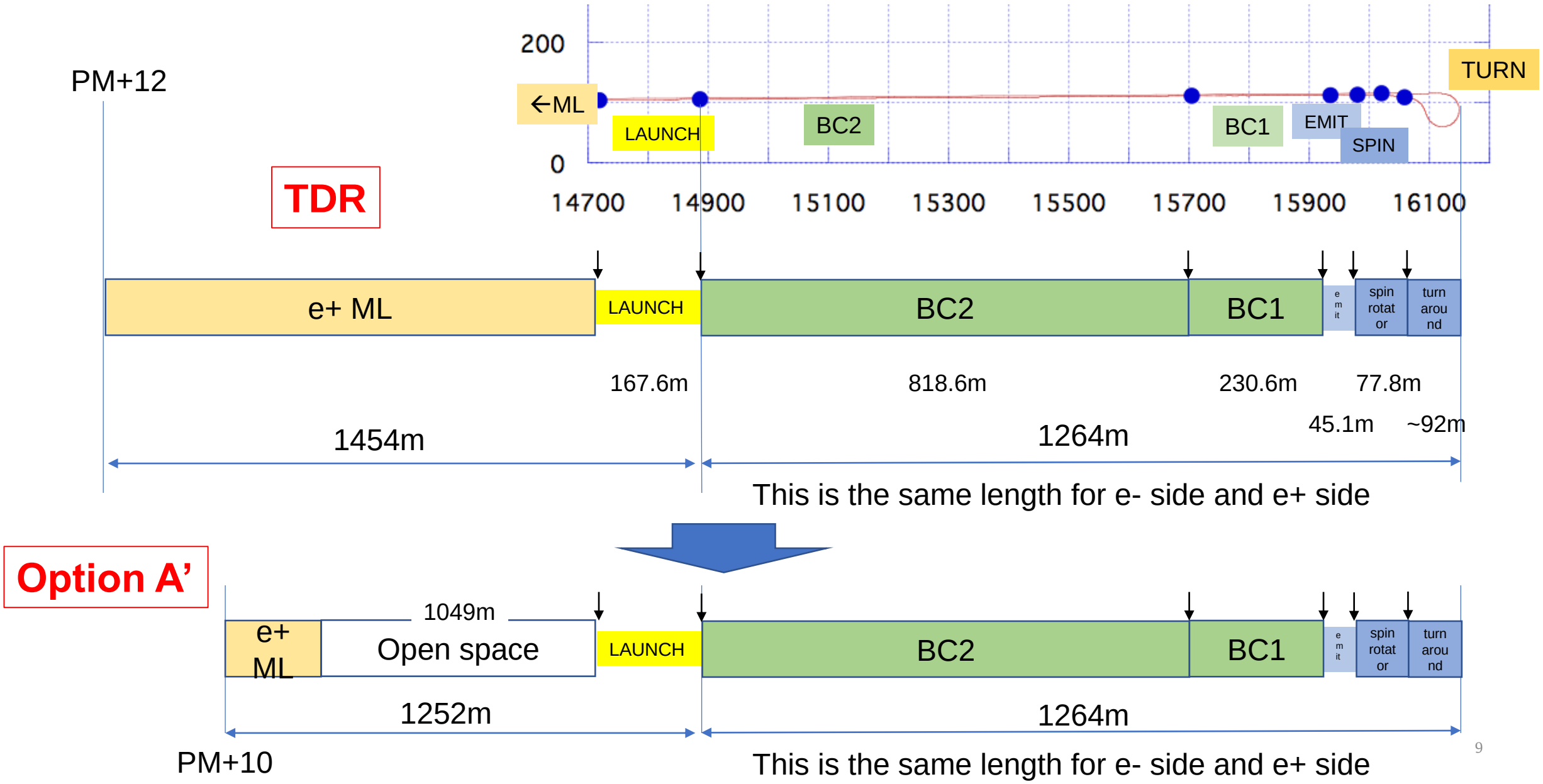
X = 404.04 m
Timing adjust

Keep BDS tunnel length as TDR, but put verical bend 87.5m on both entrance of BDS

There is no vertical bend in the optics deck.



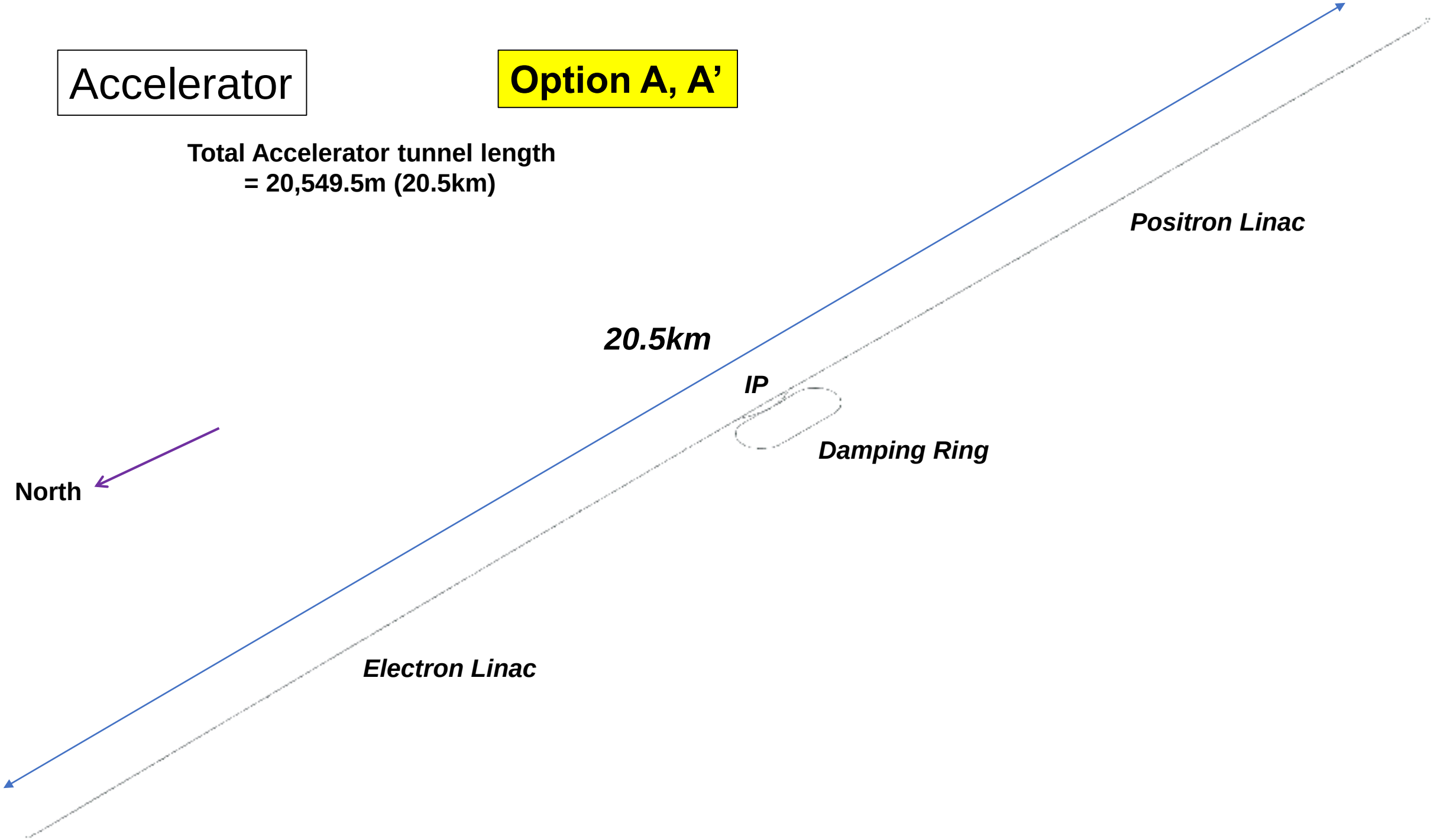
e+ Main Linac end region details



Accelerator

Option A, A'

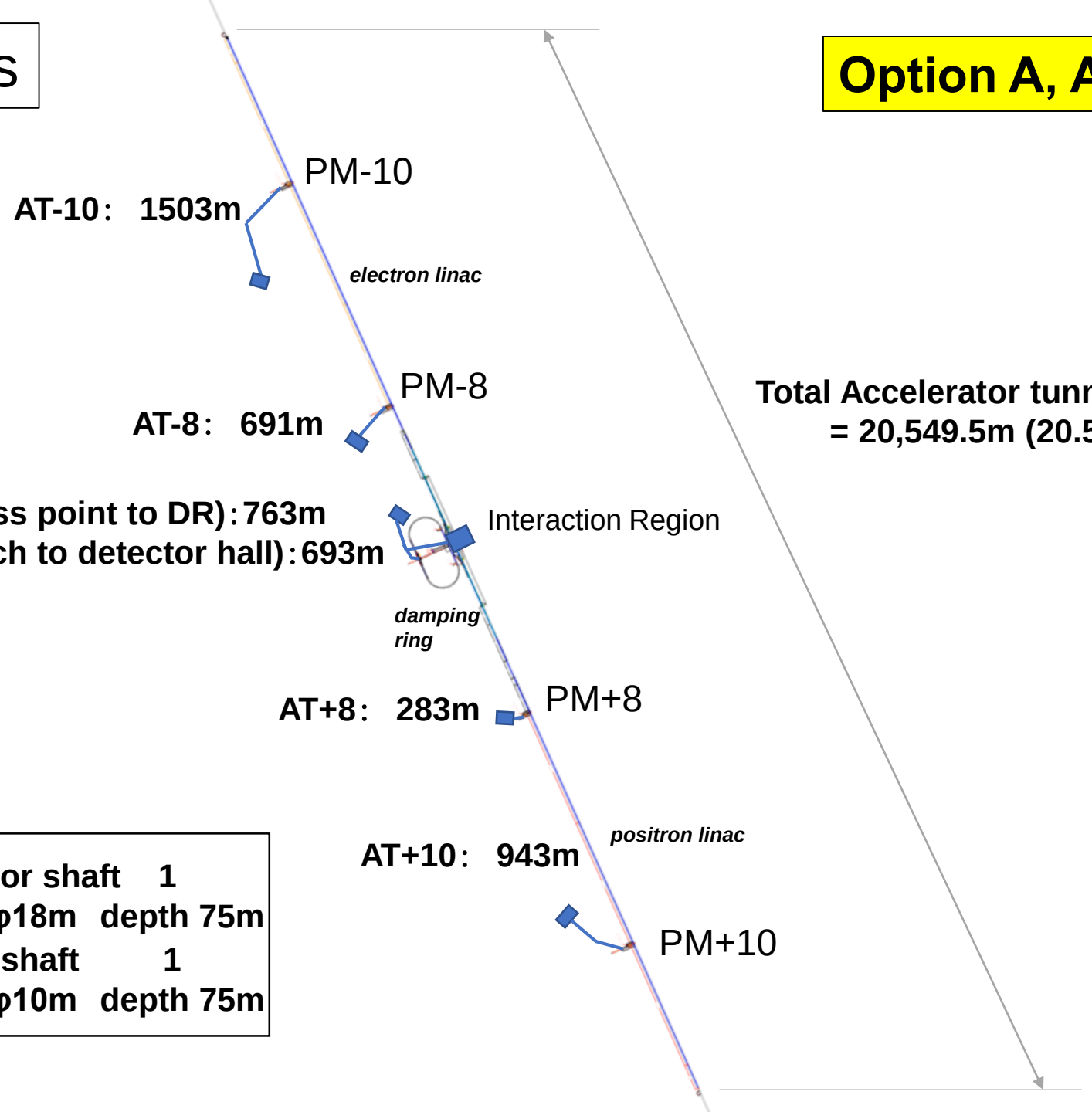
Total Accelerator tunnel length
= 20,549.5m (20.5km)



Access Tunnels

Site-specific design of Access tunnels

Option A, A'



Total Accelerator tunnel length = 20,549.5m (20.5km)

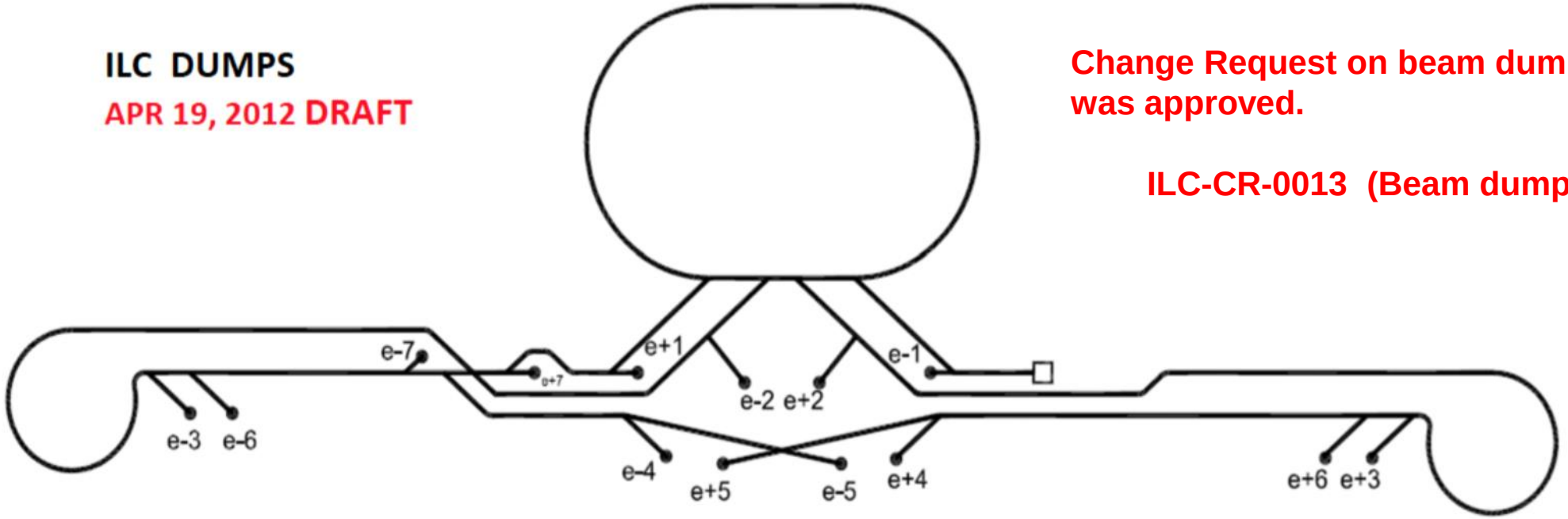
access tunnels	**5**	**Detector shaft**	**1**
total length	**4876m**	**φ18m**	**depth 75m**
		Utility shaft	**1**
		φ10m	**depth 75m**

ILC250 beam dump review

Beam Dump

ILC DUMPS

APR 19, 2012 DRAFT



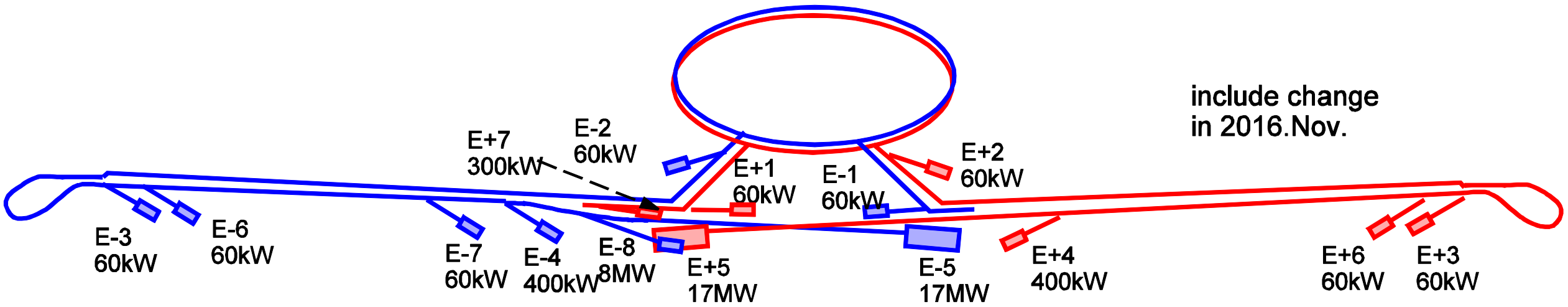
Change Request on beam dump in 2016 was approved.

ILC-CR-0013 (Beam dump)

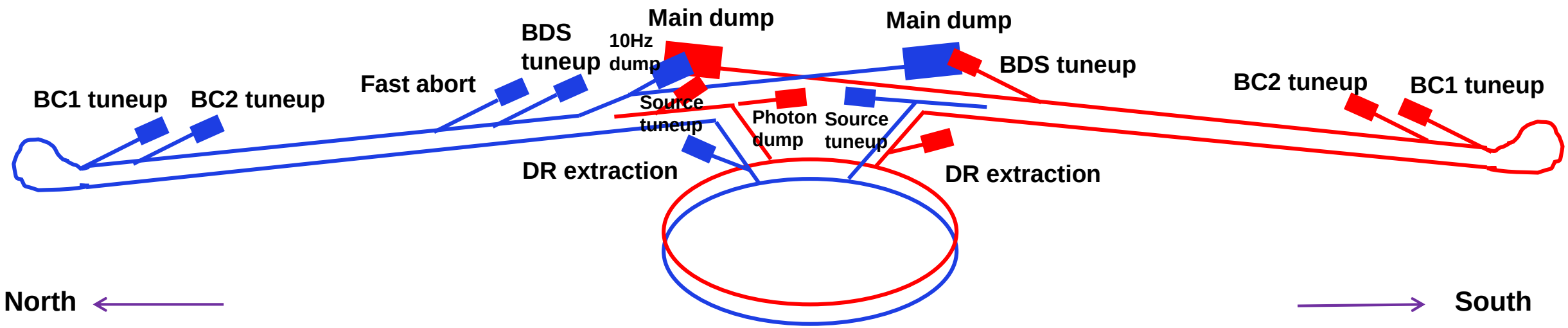
MPD	e-1	SC TUNE UP DUMP	~~311 KW~~	60kW	MPD	e+1	SC TUNE UP DUMP	~~311 KW~~	60kW
MPD	e-2	EDRX TUNE UP DUMP	~~220 KW~~	60kW	MPD	e+2	PDRX TUNE UP DUMP	~~220 KW~~	60kW
MPD	e-3	RTML TUNE UP DUMP	~~220 KW~~	60kW	MPD	e+3	RTML TUNE UP DUMP	~~220 KW~~	60kW
~~HPD~~	e-4	BDS TUNE UP DUMP	~~14 MW~~	400kW	~~HPD~~	e+4	BDS TUNE UP DUMP	~~14 MW~~	400kW
HPD	e-5	PRIMARY e-DUMP	~~14 MW~~	17MW	HPD	e+5	PRIMARY e+DUMP	~~14 MW~~	17MW
MPD	e-6	RTML TUNE UP DUMP	~~220 KW~~	60kW	MPD	e+6	RTML TUNE UP DUMP	~~220 KW~~	60kW
MPD	e-7	electron fast abort dump	~~250 KW~~	60kW	MPD	e+7	TARGET DUMP	~~200 KW~~	300kW
	e-8	**electron 10Hz dump**	**8MW**						
MPD	*= HIGH POWER DUMPs (1e-; 3e+; 6 RTML)*				** = indicate non-stop dump (always on)*				
HPD	*=MEDIUM POWER DUMPs (4 BDS)*				***= indicate 45KW always on*				

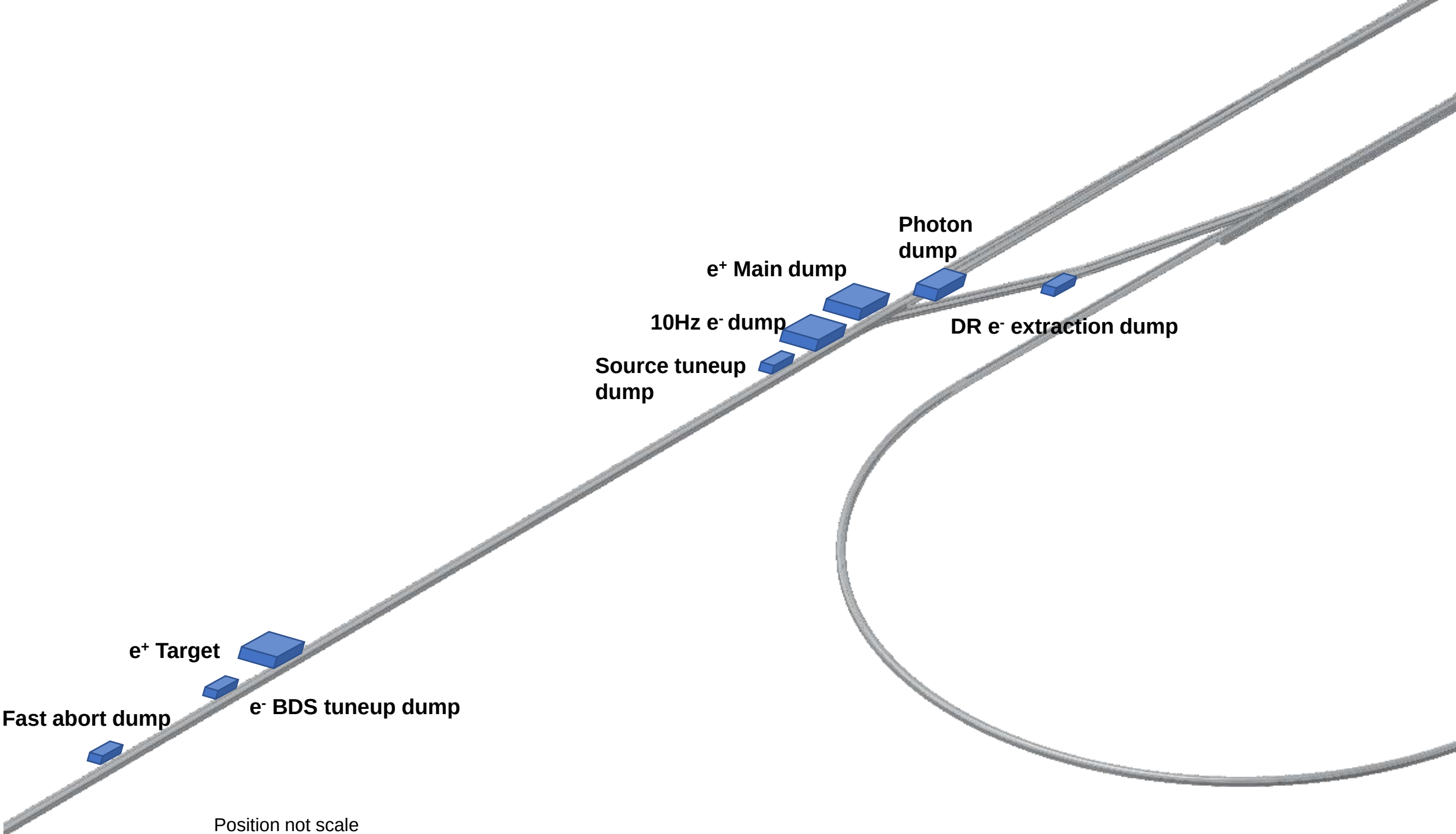
ILC-CR-0013 (Beam dump)

Quantity	Unit	Dump e±1 Source Tune-Up Dump	e±2 DR extraction dump	e±3 BC1 tune-up dump	e-4 Electron BDS tune-up dump	e+4 Positron BDS tune-up dump	e±5 Main dump	e±6 Electron BC2 tune-up dump	e-7 Electron fast abort dump	e+7 Undulator photon dump	e-8 Electron 10 Hz dump
Particle type		e±	e±	e±	e-	e+	e±	e±	e-	gamma	e-
Absolute Maximum Ratings											
Particle energy	GeV	5	5	5	750	750	750	15	750	N/A	150
Bunch charge	nC	6.0	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**	**4.0**
Bunch energy	J	30	20	20	3004	3004	3004	60	3004	18	600
Abort Dump Maximum Ratings											
Dumped pulse length	μs		10.8	113	1.7	113	1201	3.3	113		
Dumped bunches			3000	310	5	310	2888	9	310		
Dumped pulse energy	**kJ**		**60**	**6.2**	**15**	**931**	**4261**	**0.5**	**931**		
Continuous Beam Maximum Ra											
Particle energy	GeV	5	5	5	750	750	750	15	500	0.12	150
Pulse energy	kJ	79	53	53	4261	4261	4261	158	158	32	1577
Repetition rate	Hz	10	10	10	10	10	10	10	10	10	5
Average beam power	kW						**17046**			**315**	**7886**
Typical Tune-up Operational Parameters											
Particle energy	GeV	5	5	5	250	250	500	15	250	0.12	150
Bunch charge	nC	4.8	3.2	3.2	1.6	1.6	2.8	3.2	1.6	3.2	3.2
Bunches per pulse		1250	1312	1312	500	500	2450	1312	500	2625	2626
Pulse energy	kJ	30.0	21.0	21.0	200	200	3409	63.1	200.0	25.2	1262
Collision rate	Hz	2	3	3	2	2	4	1	N/A	10	5
Average beam power	kW	60	63	63	401	401	13637	63	N/A	252	6309
Nominal Power Rating	**kW**	**60**	**60**	**60**	**400**	**400**	**17000**	**60**	**60**	**300**	**8000**
TDR Power Rating	kW	311	220	220	14000	14000	14000	220	250	200	N/A

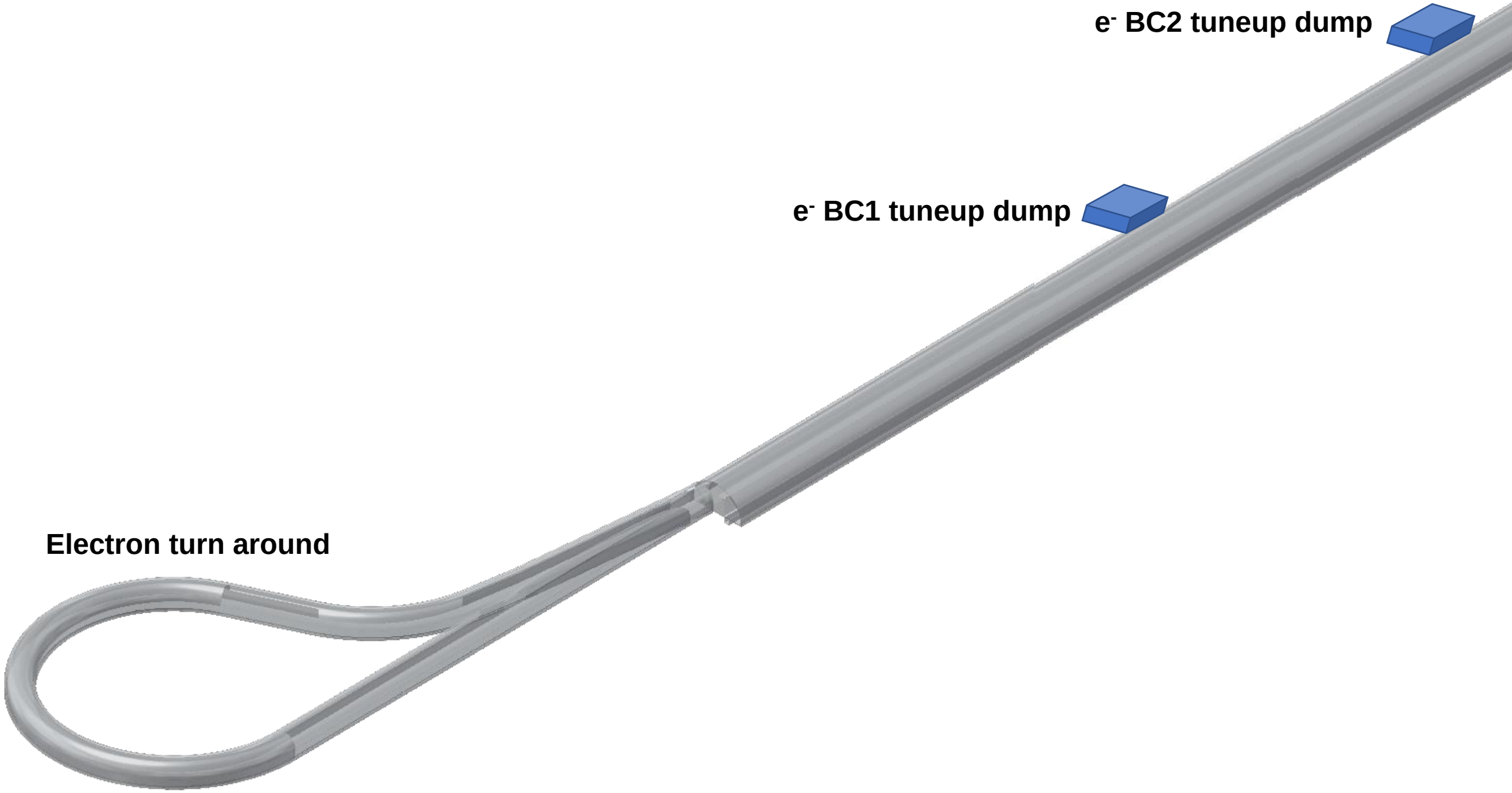


Kitakami Site-specific design





Position not scale



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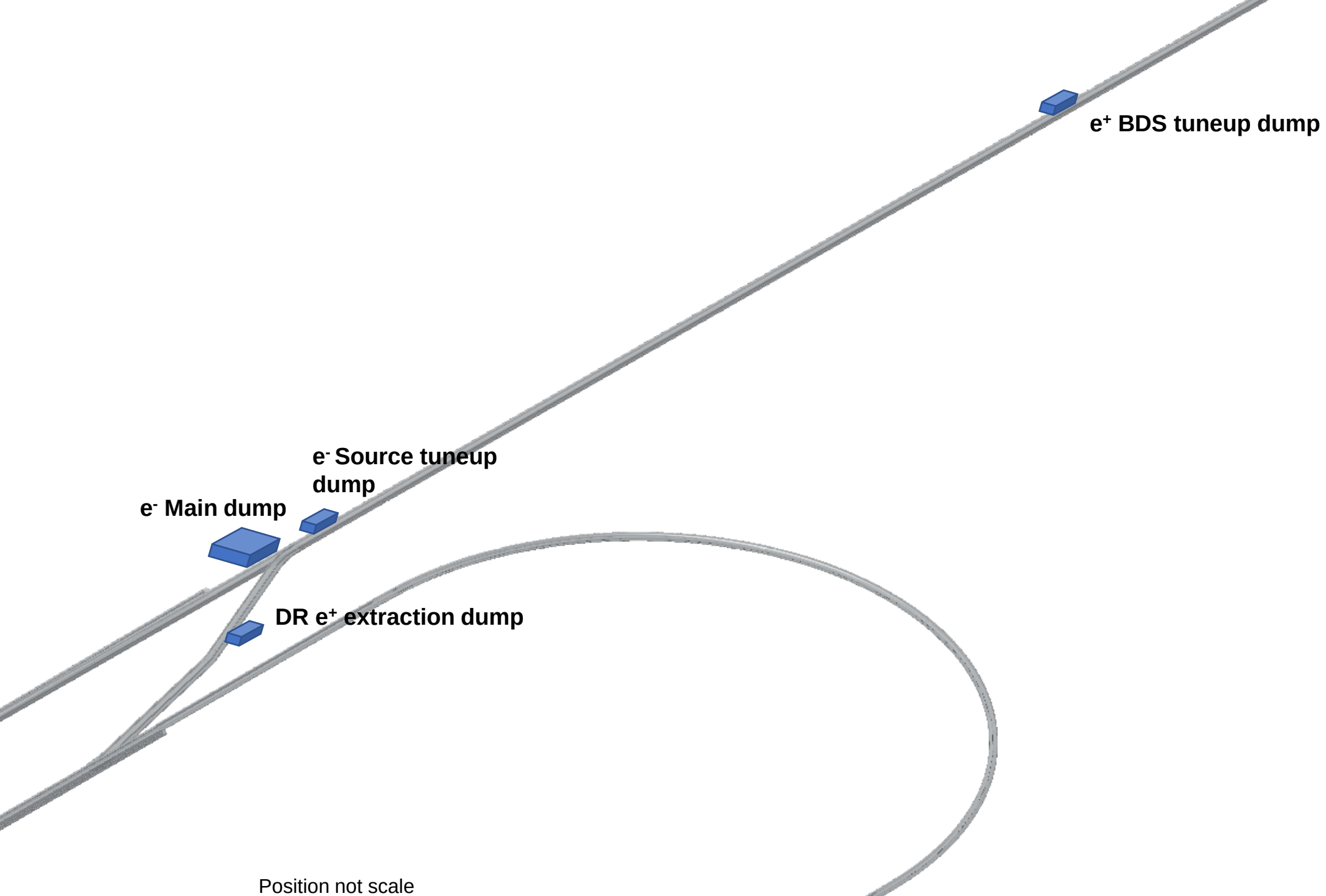
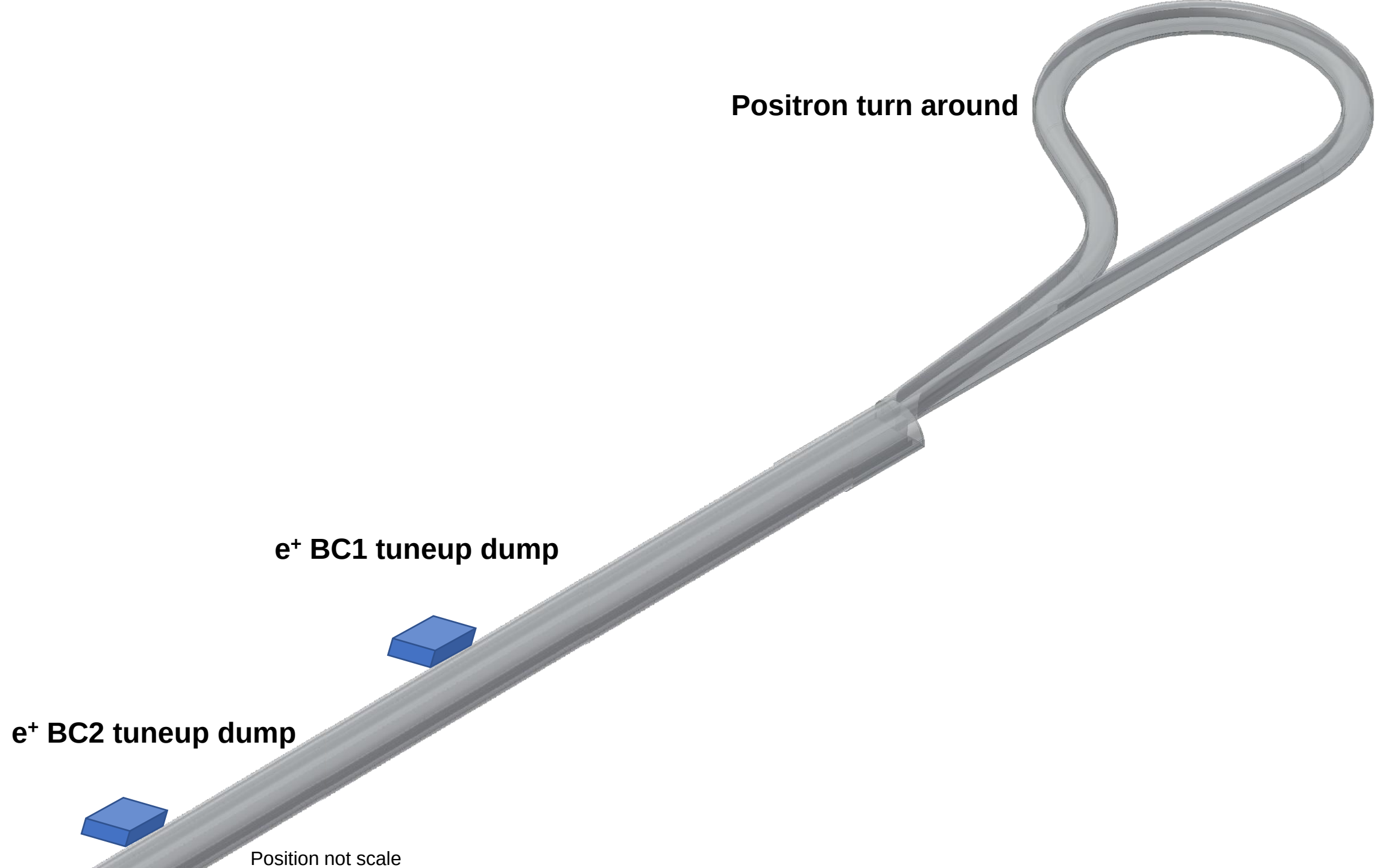
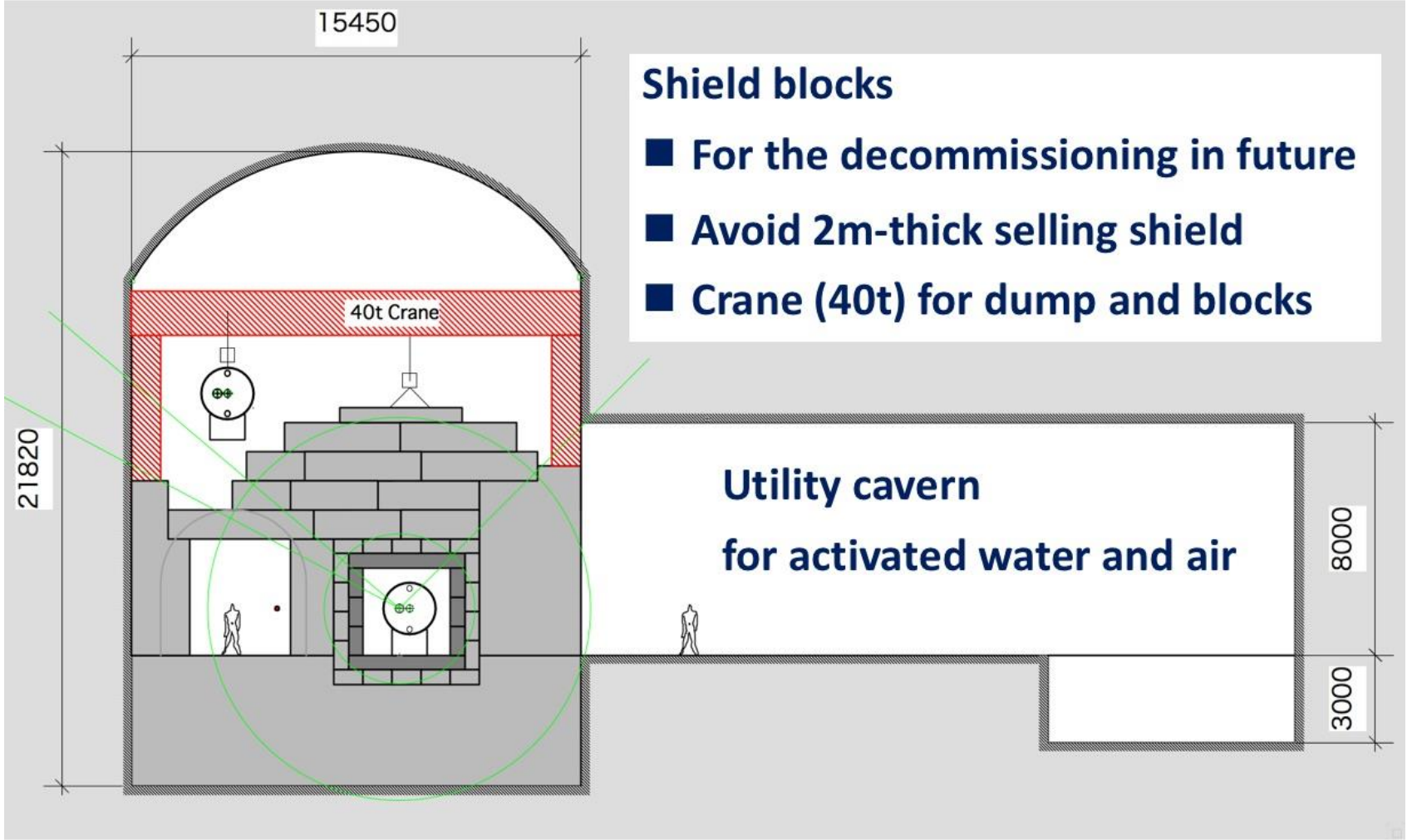


Position not scale


Positron turn around
e+ BC1 tuneup dump
e+ BC2 tuneup dump
Position not scale

Slide from N. Terunuma

Main Dump Cavern



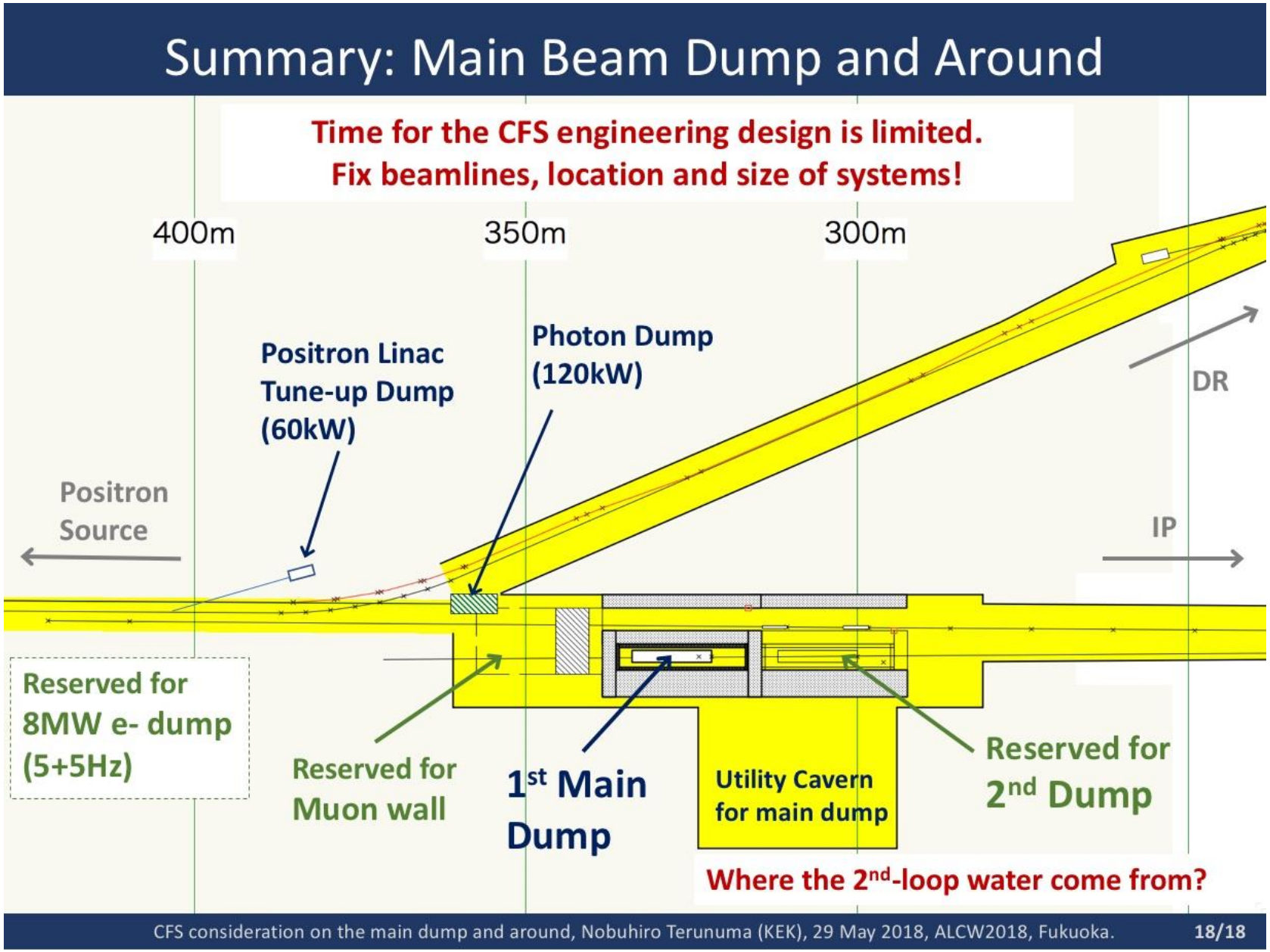
Shield blocks

- For the decommissioning in future
- Avoid 2m-thick selling shield
- Crane (40t) for dump and blocks

Utility cavern

for activated water and air

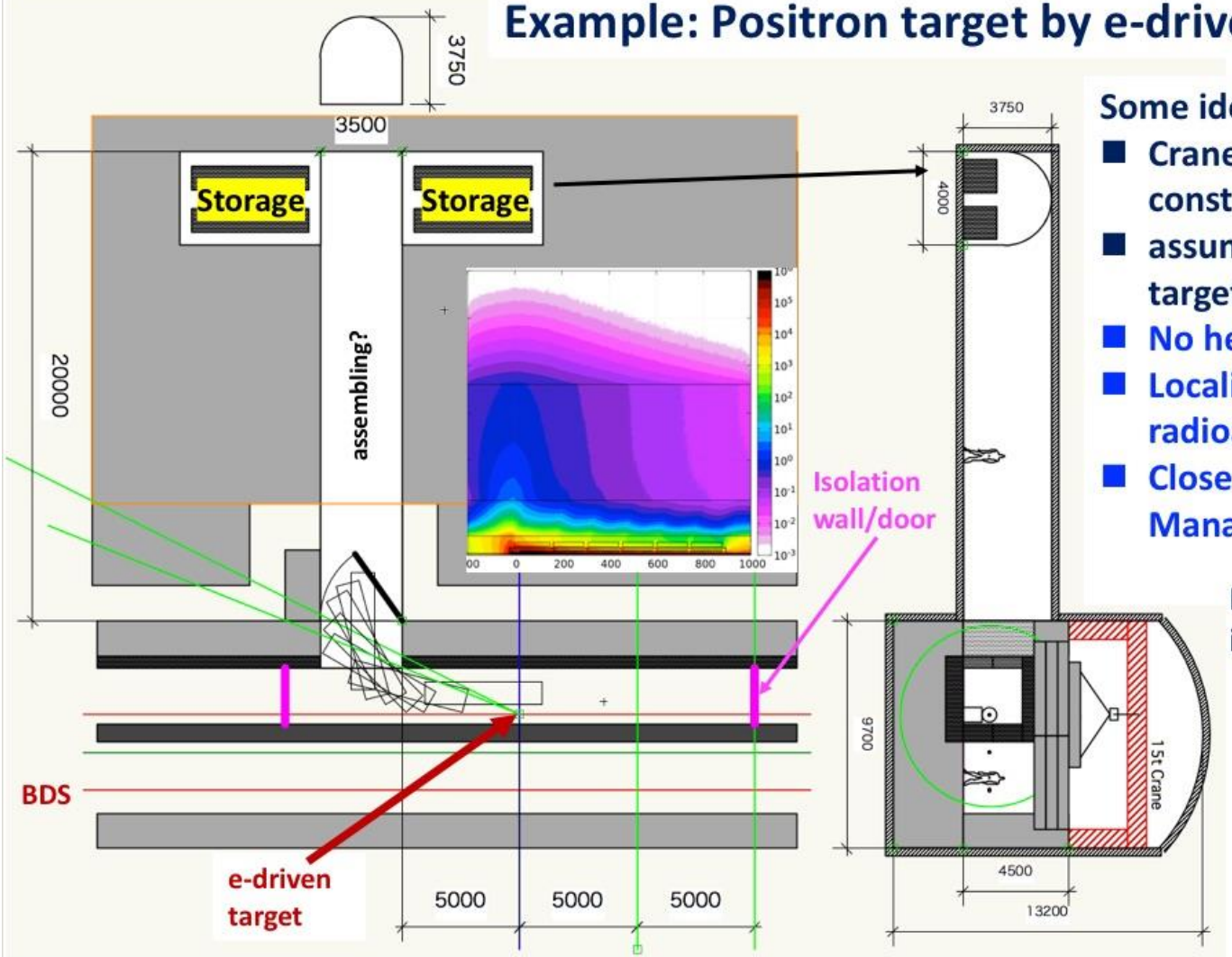
Slide from N. Terunuma



Slide from N. Terunuma

For the exchange of Positron Target

Example: Positron target by e-driven scheme



Some ideas…

- Crane is used for construction only
- assumed 5m unit for a target exchange (max?)
- No heavy door
- Localizing the radioactive work
- Closed activated air Management

Power supply room in this region:

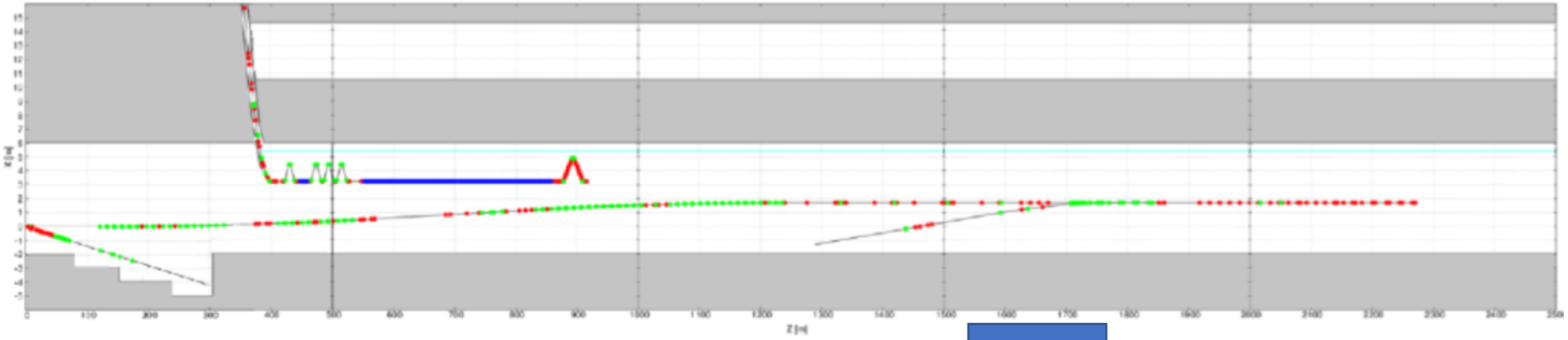
- Where?
- Anyway, we need shields.
- More wider/higher cavern?

ILC250 positron-side BDS review

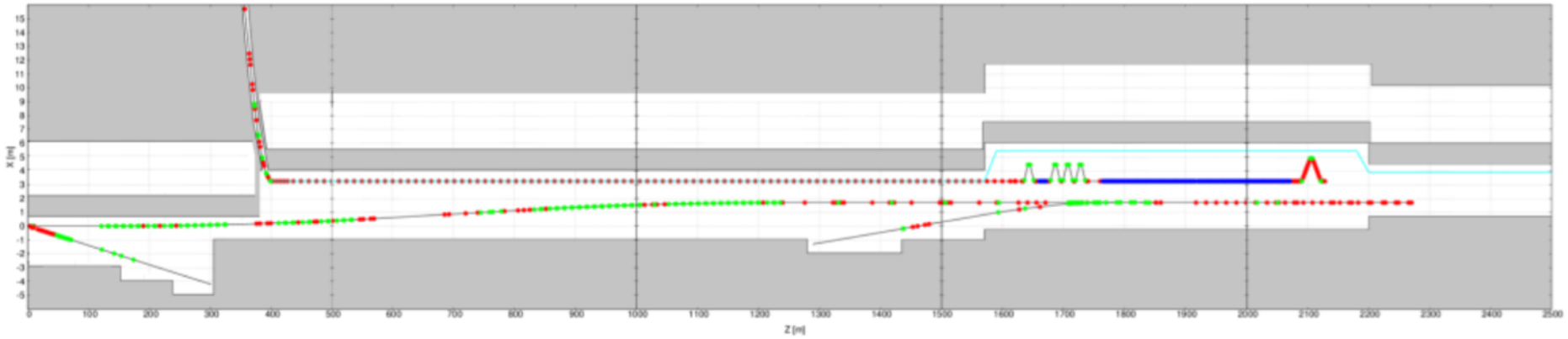
Change Request on positron BDS tunnel configulation in 2017 was approved.

ILC-CR-0015 (Kamaboko shaped positron BDS tunnel)

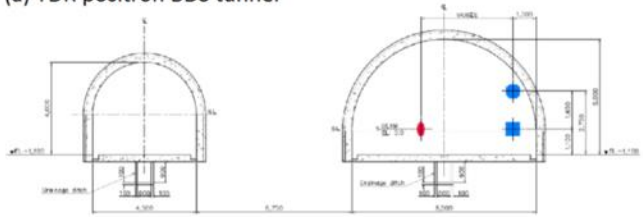
(a) TDR positron BDS tunnel



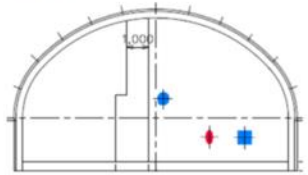
(b) proposed positron BDS tunnel



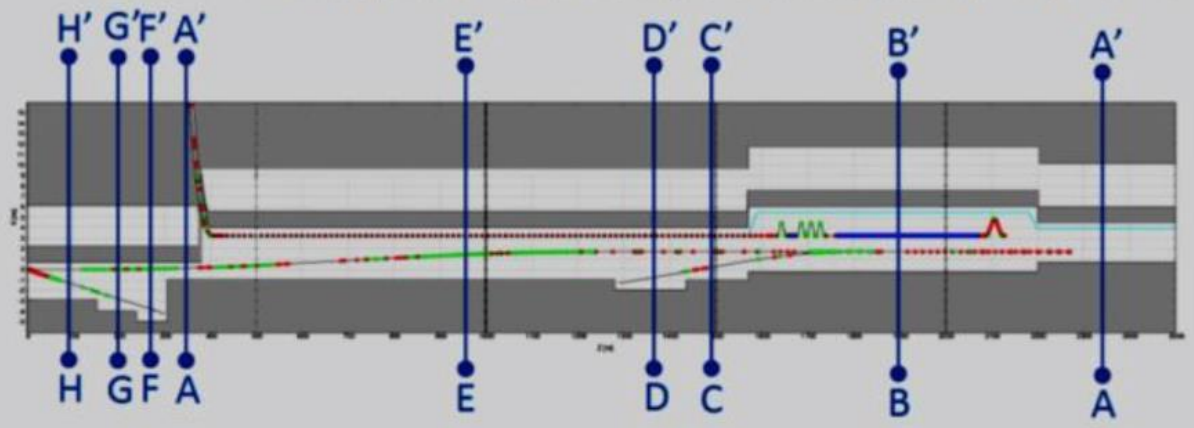
(a) TDR positron BDS tunnel

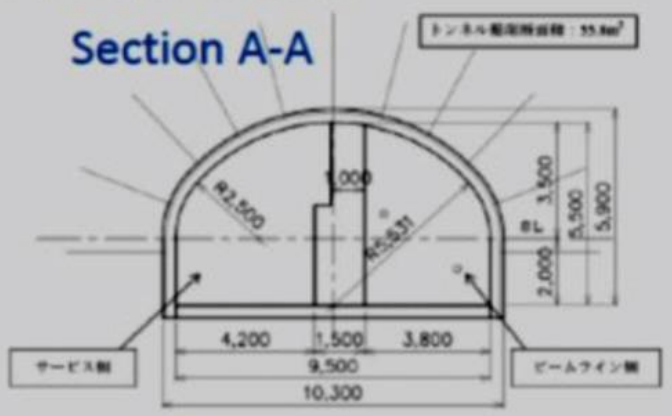


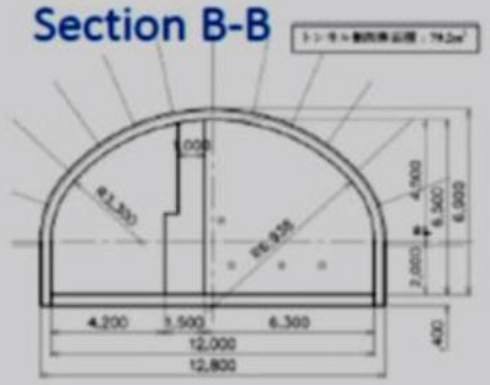
(b) proposed positron BDS tunnel

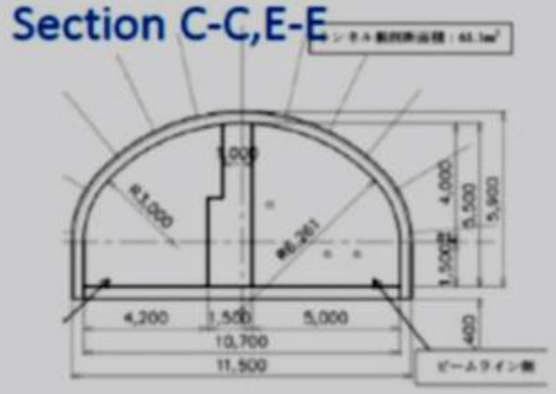


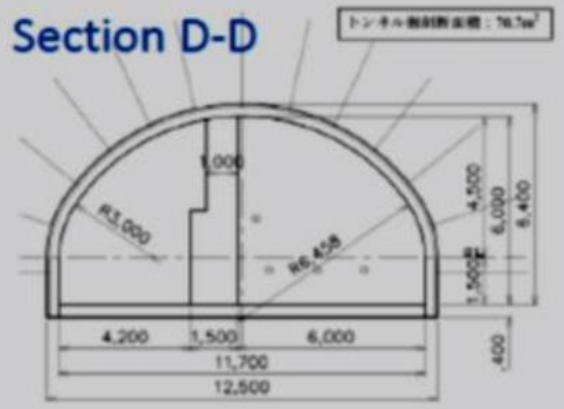
Tunnel Cross-section of Positron BDS

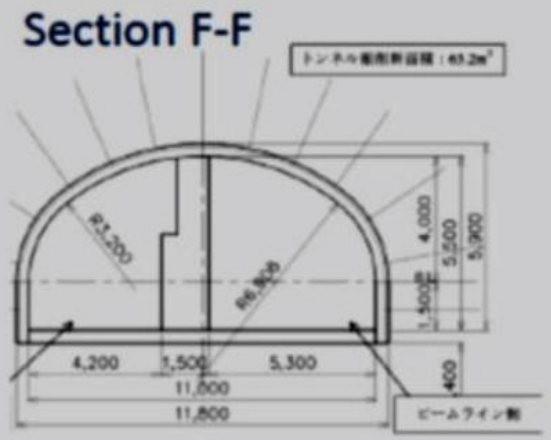


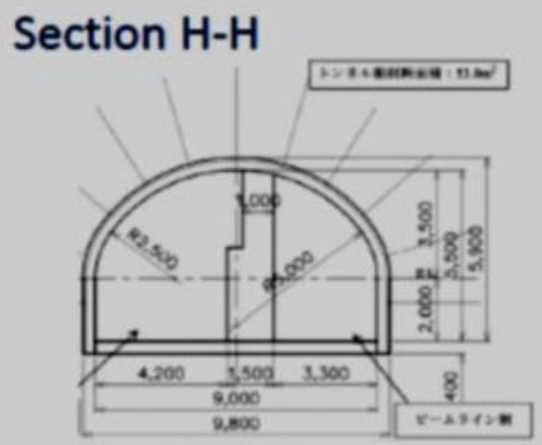








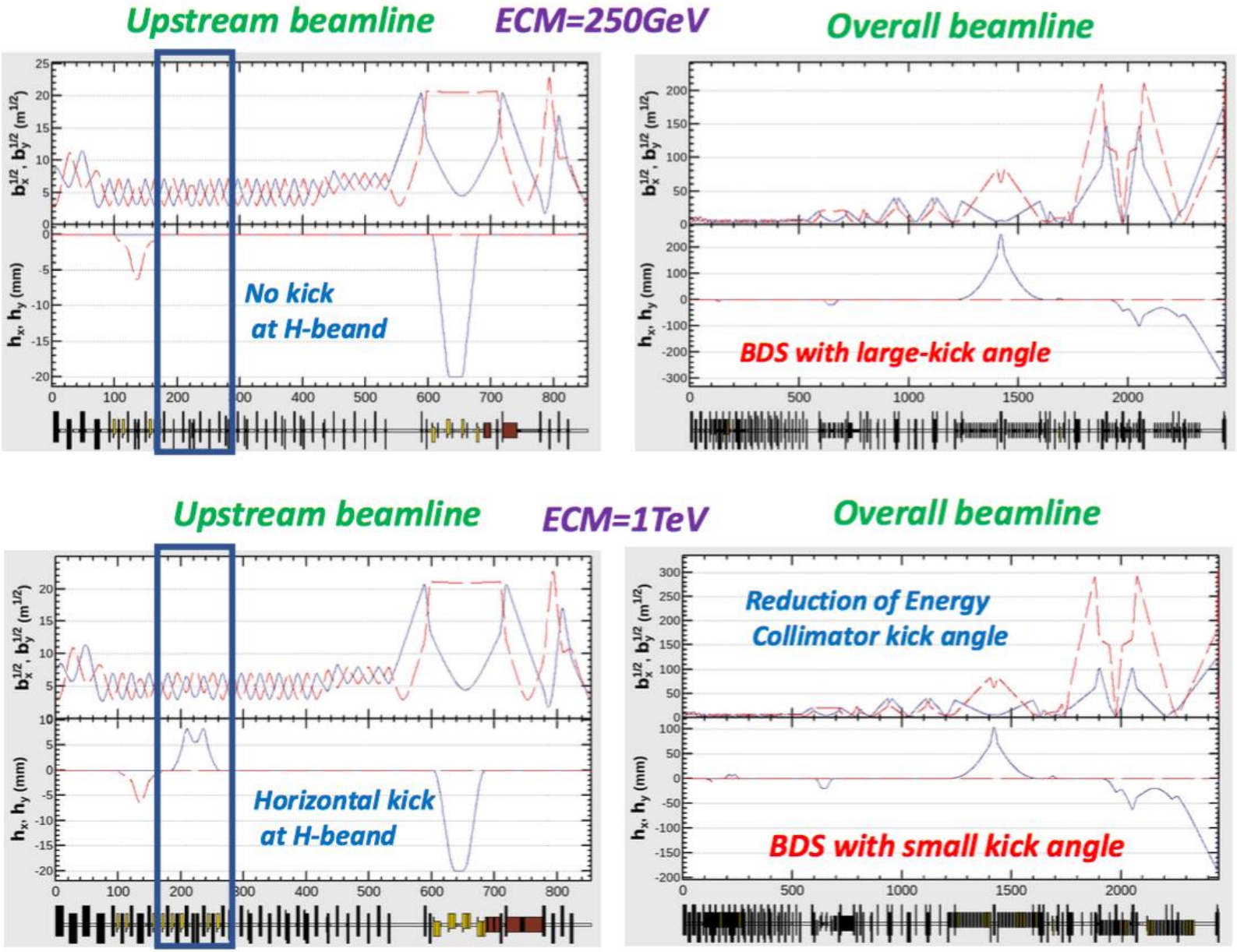




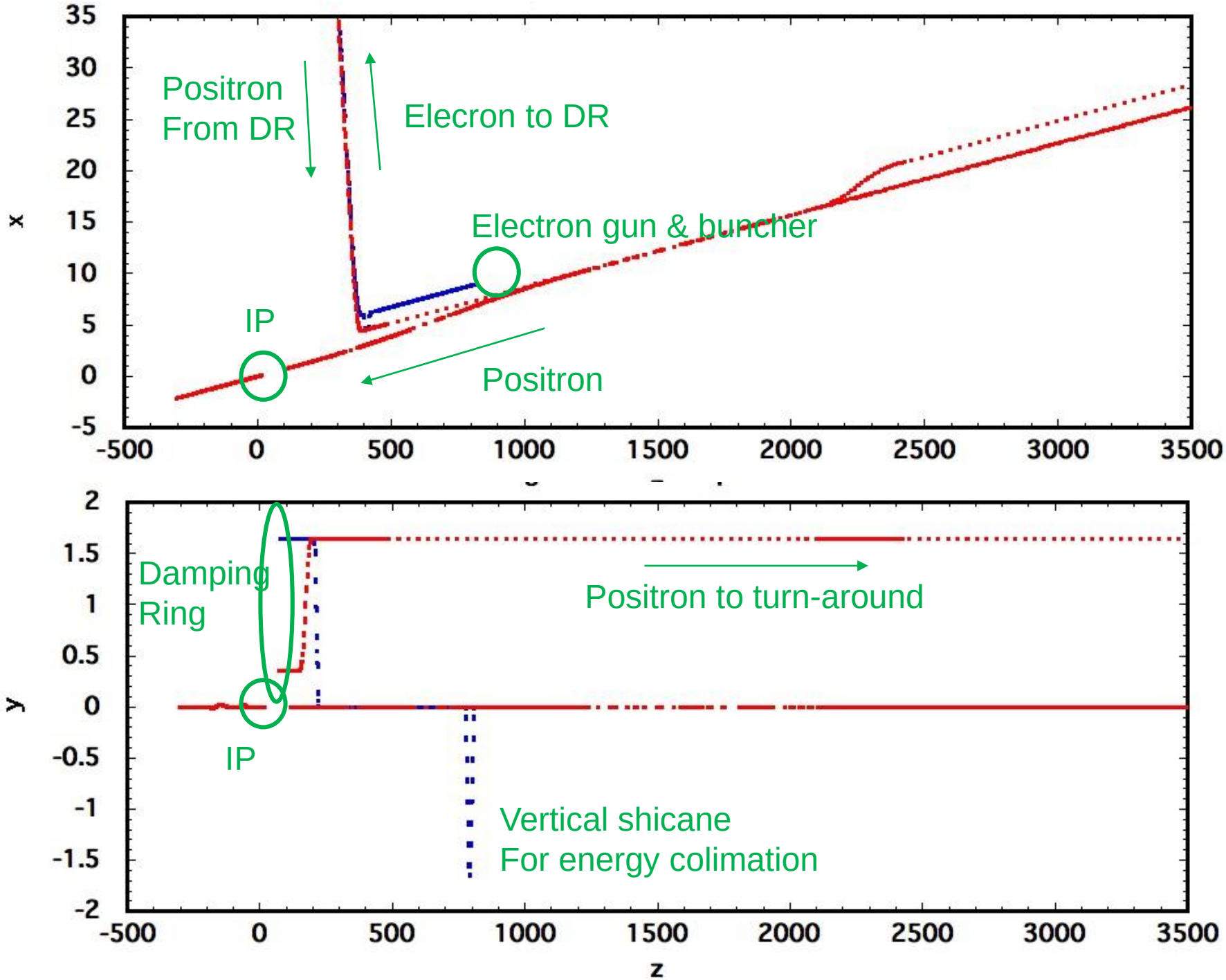
Slide from T. Okugi

Beam optics for ECM=250GeV and ECM=1TeV

BDS re-design Proposal for ILC250



e^+ BDS



TDR Lattice Geometry (not for ILC250)

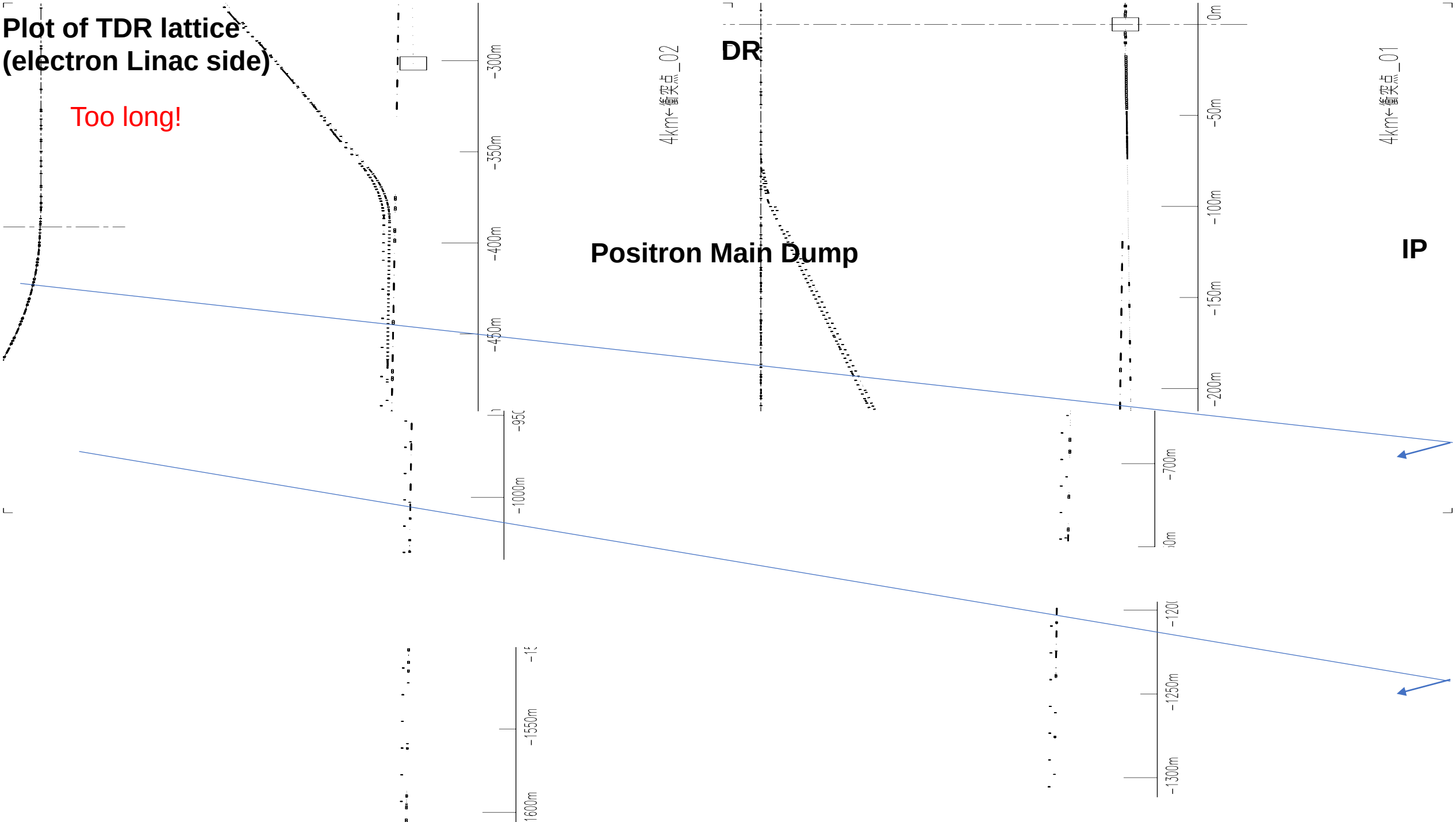
Need to revise

Move electron injector To upstream

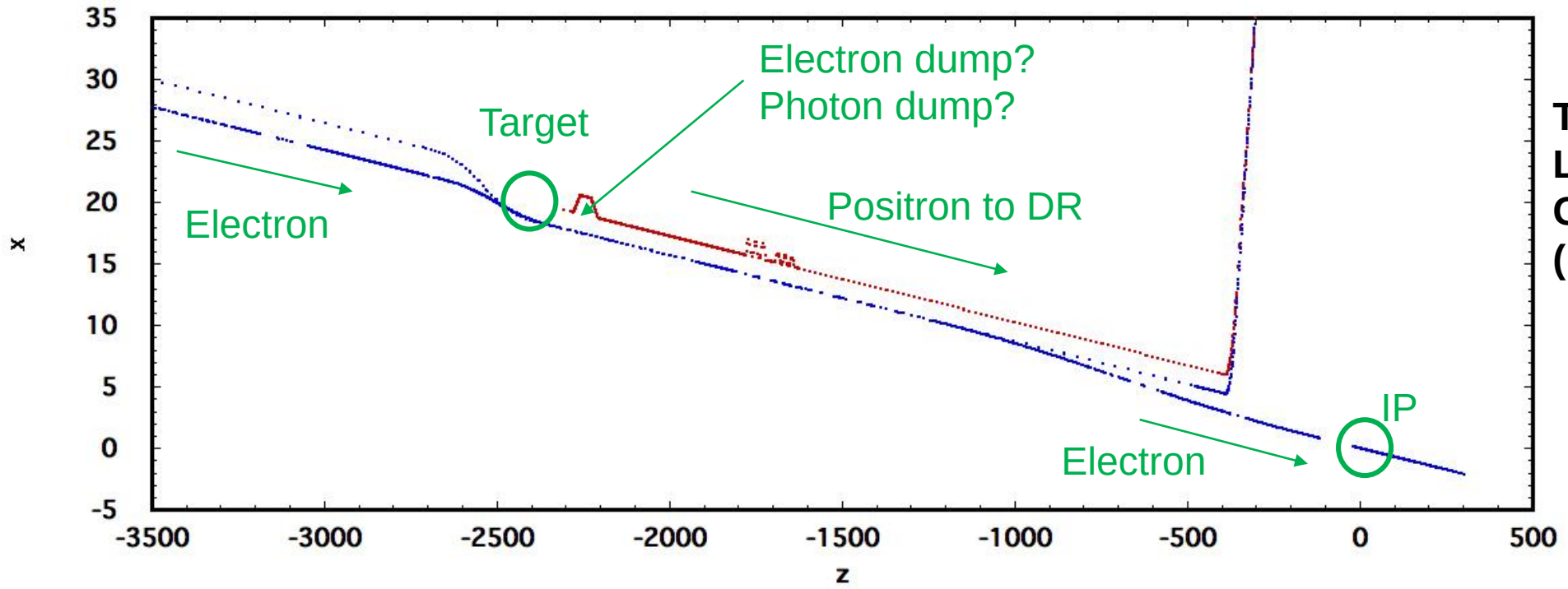
ILC250 positron generation and electron BDS review

Plot of TDR lattice (electron Linac side)

Too long!



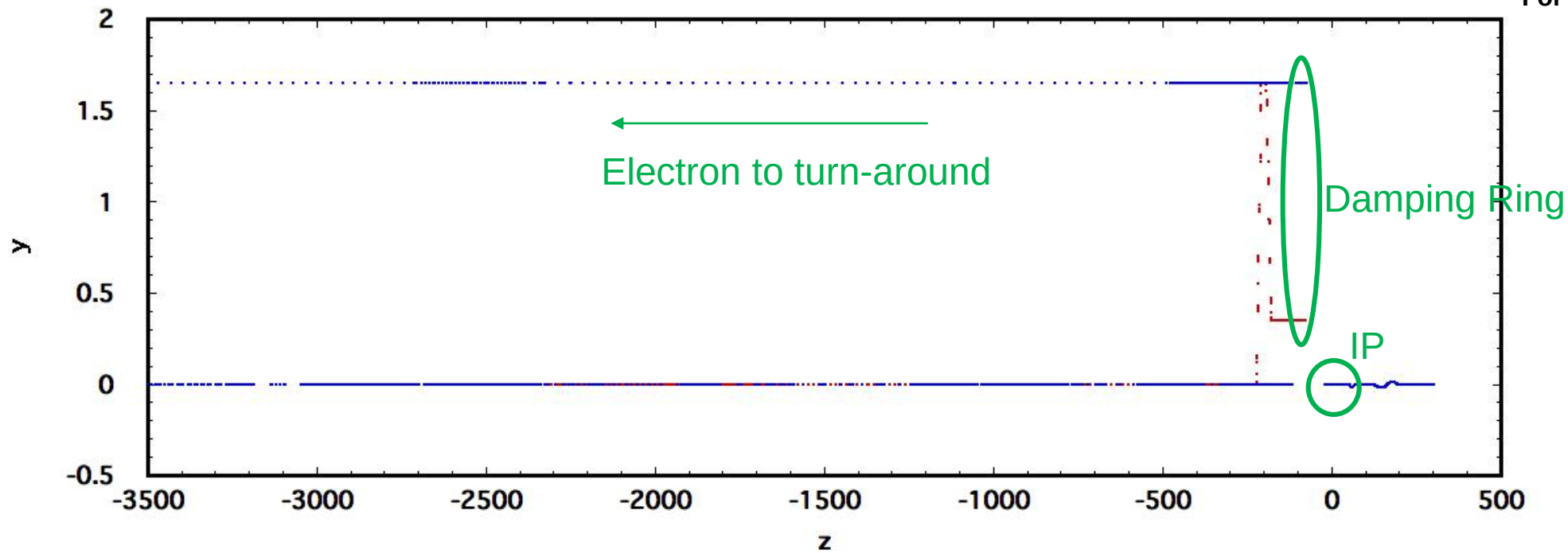
e⁻ BDS



TDR Lattice Geometry (not for ILC250)

Need to revise

Create two version?
For undulator e+
For e-driven e+

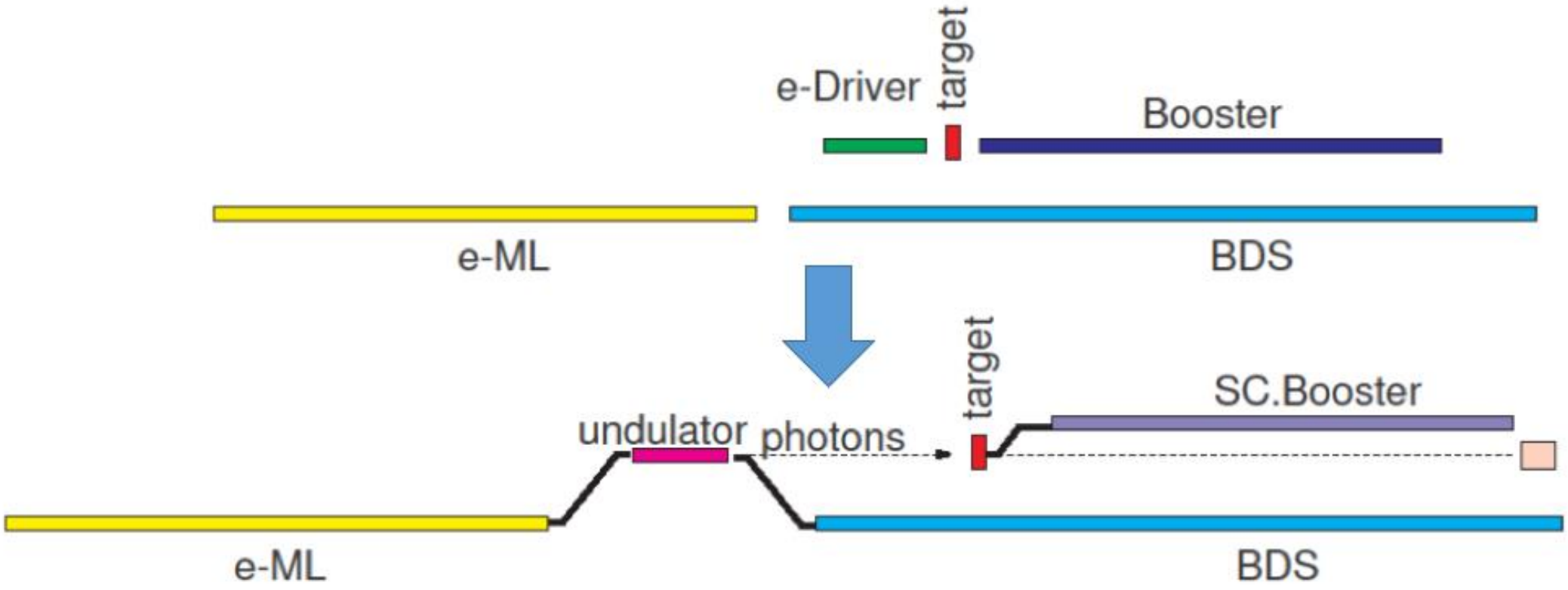


Slide from K. Yokoya

Positron source Layout examples for ILC250

example 1

- Minimum length in e-driven stage
- Requires 2 doglegs when undulator system is introduced
- Target location should not change (shielding for e-driven is larger)

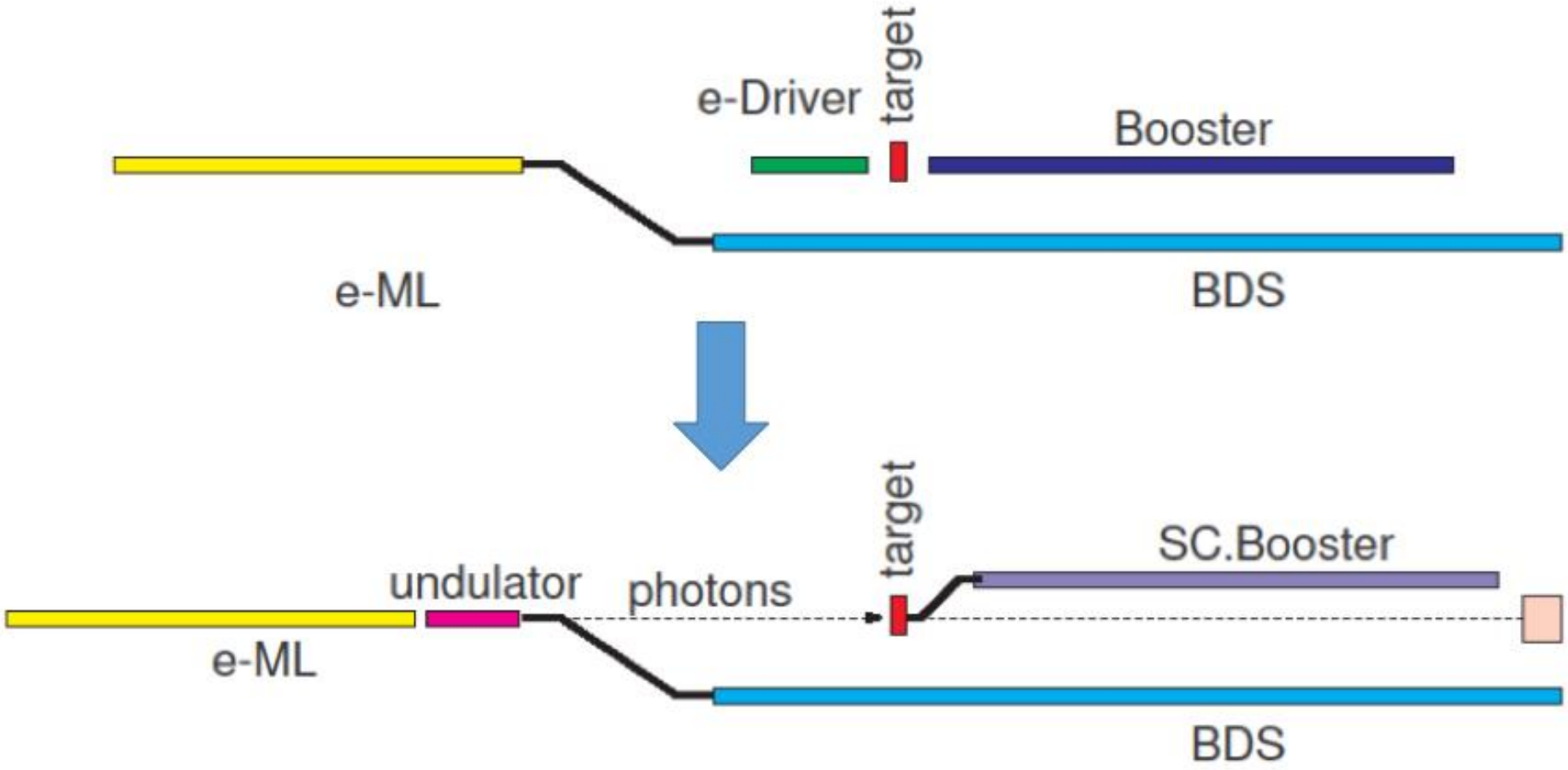


Slide from K. Yokoya

Positron source Layout examples for ILC250

example 2

- A dogleg inserted at e-driven stage as in TDR

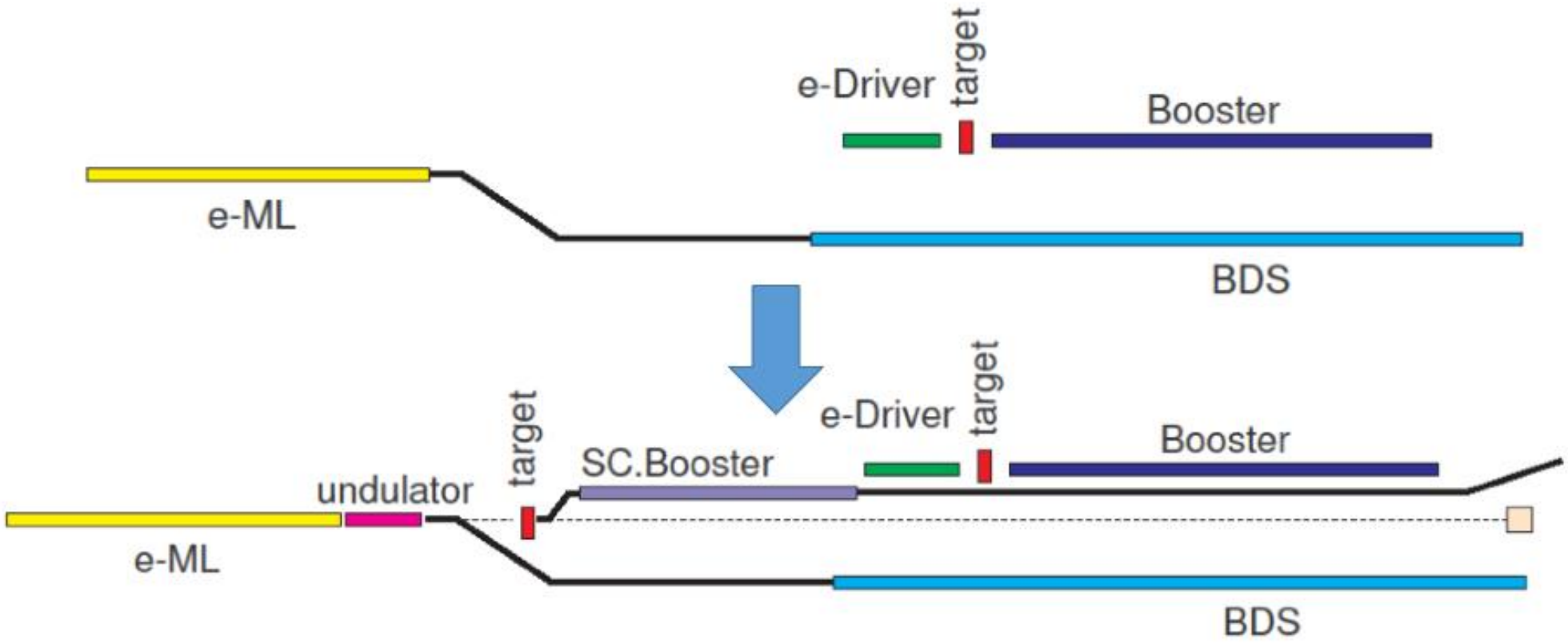


Slide from K. Yokoya

example 3

Positron source Layout examples for ILC250

- Longest e-driven stage
- Target location for undulator system should be prepared in e-driven stage

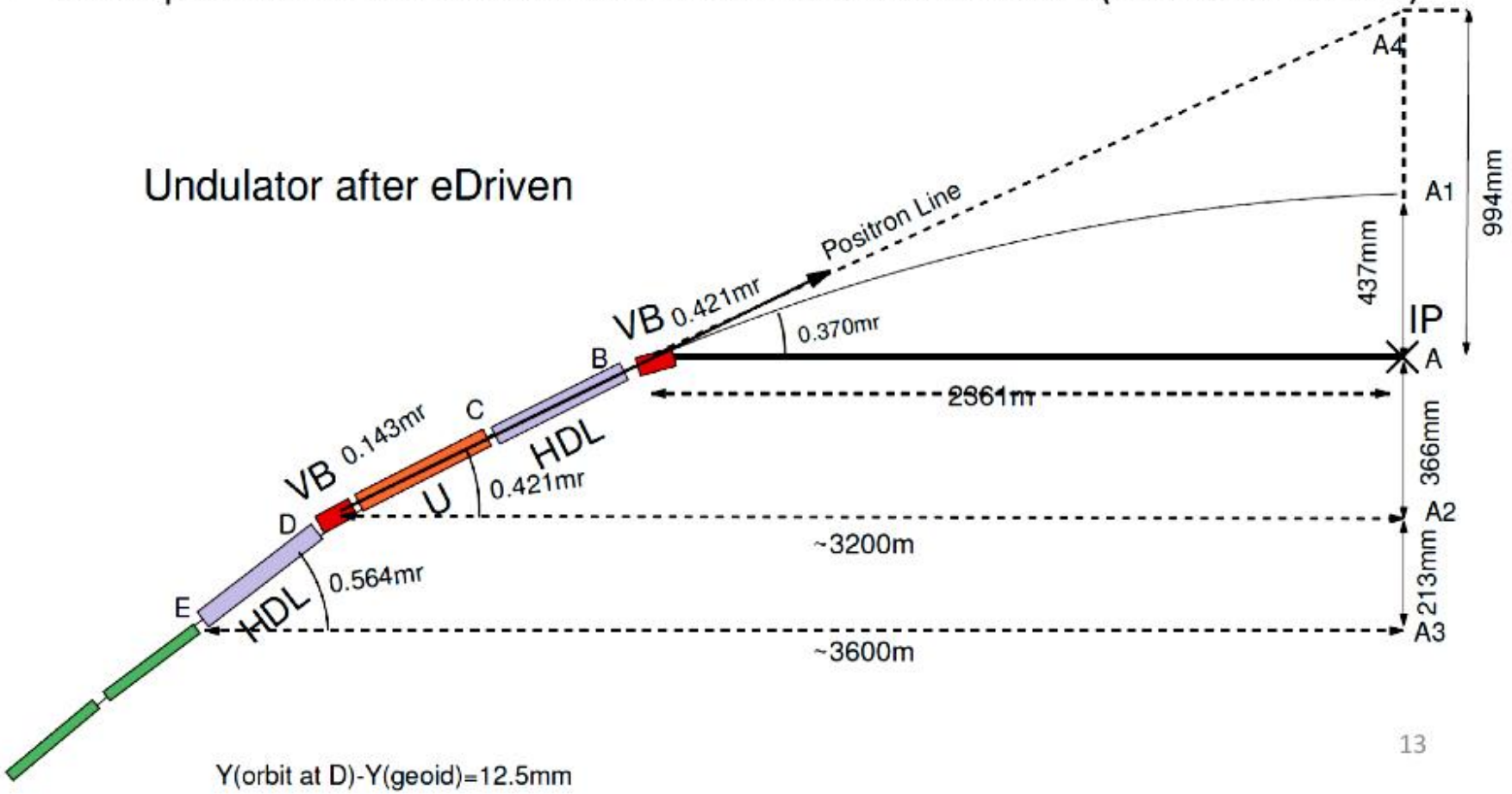


Slide from K. Yokoya

Positron source Layout examplesl for ILC250

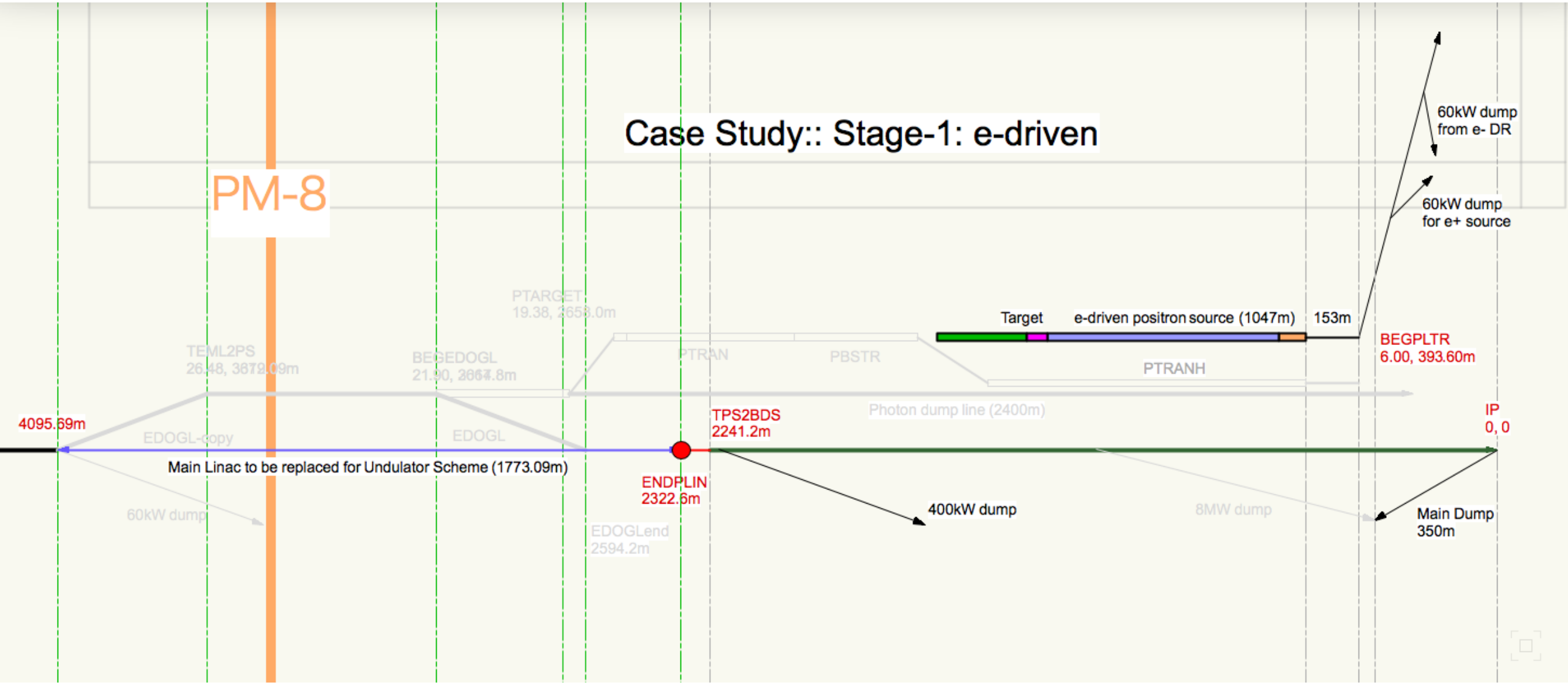
Vertical Layout : Undulator after eDriven

- Distances only tentative
- VB can be inserted at B,C,D,E. Here select only B,D
  - 2 constraints: Line AB must the same as in eDriven stage
  - Should not insert VB inside HDL (avoid complex spin motion)
- Line ED does not follow the geoid → Point D is 11.5mm above the geoid
- In the positron line there must be 0.421mrad VB somewhere (around 400MeV?)



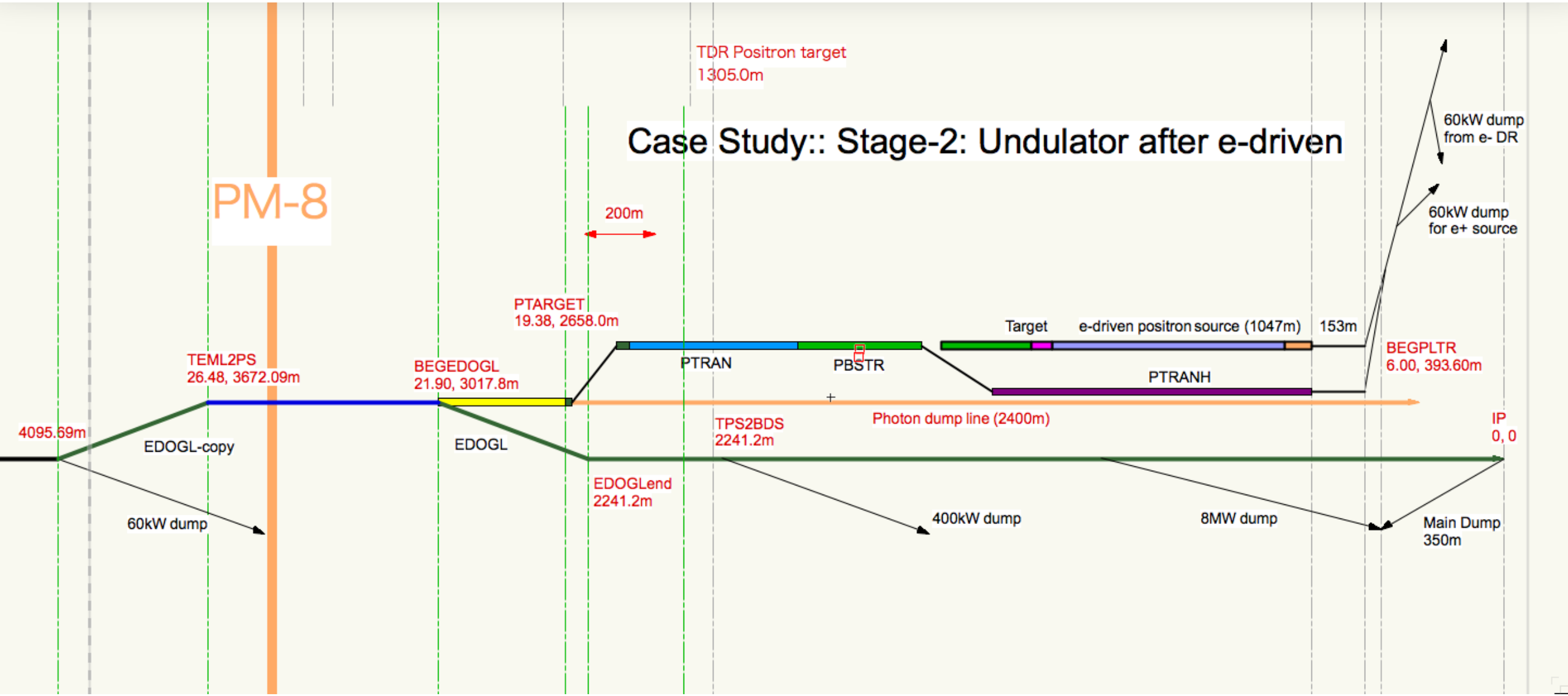
Slide from N. Terunuma

Example for discussion : e-driven positron



Slide from N. Terunuma

Example for discussion : Undulator after e-driven



Summary

1. ILC250 configuration review/update

The configulation basement exist. would like to ask the work to BD?.

2. TDR/ILC250 beam dump review/update

The change request was approved.

The designs of shield rooms are on-going

3. TDR/ILC250 positron-side BDS review/update

The change request was approved, and the design exist.

4. TDR/ILC250 positron generation and electron BDS review/update

Need to fix the lattice designs, layout designs for both option

End of slide